

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C.20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 21 March 2000 (21.03.00)	
<b>International application No.</b> PCT/US99/08870	<b>Applicant's or agent's file reference</b> T4585.CIP.PCT
<b>International filing date</b> (day/month/year) 22 April 1999 (22.04.99)	<b>Priority date</b> (day/month/year) 22 April 1998 (22.04.98)
<b>Applicant</b> ALLAIRE, Paul, E. et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
30 September 1999 (30.09.99)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

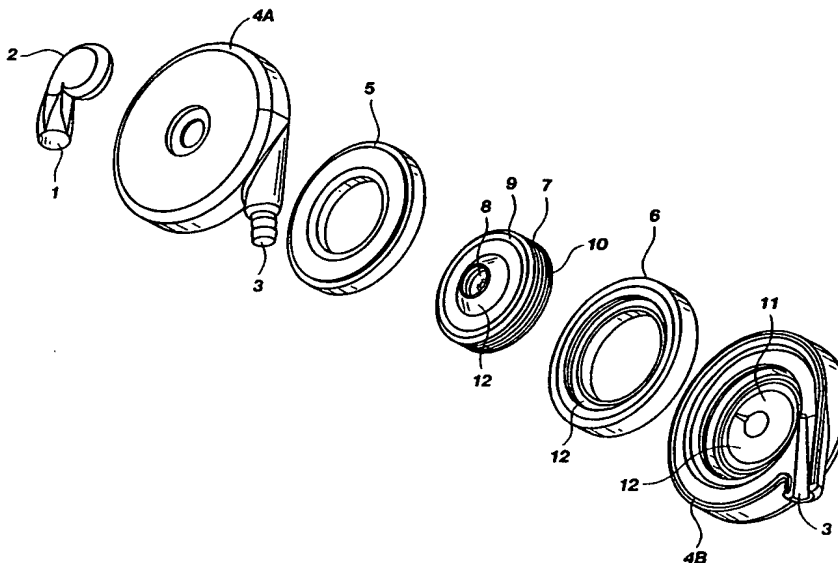
<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer R. Forax</p> <p>Telephone No.: (41-22) 338.83.38</p>
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>F04B 17/03, A61F 2/24</b>		A3	(11) International Publication Number: <b>WO 99/53974</b>
			(43) International Publication Date: 28 October 1999 (28.10.99)
(21) International Application Number: <u>PCT/US99/08870</u>			
(22) International Filing Date: 22 April 1999 (22.04.99)			
(30) Priority Data: 09/064,352 22 April 1998 (22.04.98) US			
(71) Applicants (for all designated States except US): UNIVERSITY OF UTAH [US/US]; Suite 170, 421 Wakara Way, Salt Lake City, UT 84121 (US). MEDQUEST PRODUCTS, INC. [US/US]; Suite NE107, 825 North 300 West, Salt Lake City, UT 84103 (US). UNIVERSITY OF VIRGINIA [US/US]; Washington Hall, P.O. Box 9025, Charlottesville, VA 22906 (US).			
(72) Inventors; and (75) Inventors/Applicants (for US only): VALLAIRE, Paul, E. [US/US]; 805 Emerson Drive, Charlottesville, VA 22901 (US). BEARNSON, Gill, B. [US/US]; 982 East Jasper Circle, Salt Lake City, UT 84106 (US). FLACK, Ron [US/US]; 4265 Viewmont Road, Earlysville, VA 22936 (US). VOLDSEN, Don, B. [US/US]; 8832 Blue Jay Lane, Salt Lake City, UT 84121 (US). LONG, James, W. [US/US]; 4461 South Parkview Drive, Salt Lake City, UT 84124 (US). KUMAR, B., Ajit [IN/US]; Suite NE107, 825 North 300 West, Salt Lake City, UT 84103 (US). KHANWILKAR,			
		(74) Agents: NORTH, Vaughn, W. et al.; Thorpe, North & Western, LLP, P.O. Box 1219, Sandy, UT 84091-1219 (US).	
		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
		(88) Date of publication of the international search report: 9 March 2000 (09.03.00)	

(54) Title: IMPLANTABLE CENTRIFUGAL BLOOD PUMP WITH HYBRID MAGNETIC BEARINGS



## (57) Abstract

A pump for pumping sensitive fluids, such as blood, having no mechanical contact between the impeller and any other structure. The pump comprises a pump housing (4), an impeller (7) disposed within the pump housing, a magnetic bearing system (5, 6) for supporting and stabilizing the impeller (7) in five degrees of freedom, and a conformally shaped magnetically linked motor for rotating the impeller (7). The magnetic bearing system (5, 6) and motor advantageously comprise electromagnets and permanent magnets (18) for stability and control of the impeller (7) and to reduce size, weight and pump power consumption. Permanent magnets (18) and electromagnets are disposed on the pump housing (4) and permanent magnets (18) are disposed on the impeller (7) such that by controlling electric current through the electromagnets on the housing, the magnetically suspended impeller (7) functions as the rotor and the housing as the stator of a D.C. motor. The system advantageously allows for sensing of relative impeller position and dynamic properties without the need for additional sensors.

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EE	Estonia	LR	Liberia	SG	Singapore		

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/08870

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F04B 17/03; A61F 2/24

US CL : 417/356; 623/3

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 417/356; 623/3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
none

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,470,208 A (KLETSCHKA) 28 NOVEMBER 1995, ENTIRE PUBLICATION	1-30

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
16 JUNE 1999Date of mailing of the international search report  
20 JAN 2000Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231Authorized officer  
DAVID J ISABELLA

Facsimile No. (703) 305-3230

Telephone No. (703) 308-3060

# PATENT COOPERATION TREATY

JAN 24 2000

**Thorpe, North & Western**

From the INTERNATIONAL SEARCHING AUTHORITY

To: VAUGHN W. NORTH  
THORPE, NORTH & WESTERN, LLP  
P.O. BOX 1219  
SANDY UT 84091-1219

*voluntary amendment 3-20-00*  
**PCT**

## NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

*communic abstract due 2-20-00*

Date of Mailing  
(day/month/year)

**20 JAN 2000**

Applicant's or agent's file reference

T4585.CIP.PC

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.

PCT/US99/08870

International filing date  
(day/month/year)

22 APRIL 1999

Applicant

UNIVERSITY OF UTAH

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

### Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland  
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.  
☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in rules 90 bis 1 and 90 bis 3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

DAVID J ISABELLA

Telephone No. (703) 308-3060

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/08870

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : F04B 17/03; A61F 2/24

US CL : 417/356; 623/3

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 417/356; 623/3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,470,208 A (KLETSCHKA) 28 NOVEMBER 1995, ENTIRE PUBLICATION	1-30

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

16 JUNE 1999

Date of mailing of the international search report

20 JAN 2000

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
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Facsimile No. (703) 305-3230

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DAVID J ISABELLA

Telephone No. (703) 308-3060

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EE	Estonia						

# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: **VAUGHN W. NORTH**  
**THORPE, NORTH & WESTERN, L.L.P.**  
**9035 SOUTH 700 EAST, SUITE 200**  
**SANDY, UTAH 84070**

*Report 12-24-97  
 10-24-97  
 10-24-97*

**PCT**

SEP 29 1997

THORPE NORTH & WESTERN

## NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference <b>T4585.PCT</b>	Date of Mailing (day/month/year) <b>2 4 SEP 1997</b>
International application No. <b>PCT/US97/07566</b>	International filing date (day/month/year) <b>05 MAY 1997</b>
Applicant <b>UNIVERSITY OF UTAH</b>	

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompanying sheet.

**Where?** Directly to the International Bureau of WIPO  
 34, chemin des Colombettes  
 1211 Geneva 20, Switzerland  
 Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in rules 90 bis 1 and 90 bis 3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer <i>J. Hurley for</i> <b>XUAN M. THAI</b> Telephone No. (703) 308-0975
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## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference T4585.PCT	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/US97/07566	International filing date (day/month/year) 05 MAY 1997	(Earliest) Priority Date (day/month/year) 03 MAY 1996
Applicant UNIVERSITY OF UTAH		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (See Box I).
2. ☐ Unity of invention is lacking (See Box II).
3. ☐ The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
  - ☐ filed with the international application.
  - ☐ furnished by the applicant separately from the international application,
    - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
  - ☐ transcribed by this Authority.
4. With regard to the title, ☒ the text is approved as submitted by the applicant.
  - ☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
  - ☐ the text is approved as submitted by the applicant.
  - ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the drawings to be published with the abstract is:
  - Figure No. 3 ☐ as suggested by the applicant. ☐ None of the figures.
  - ☒ because the applicant failed to suggest a figure.
  - ☐ because this figure better characterizes the invention.

**Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)**

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

**NEW ABSTRACT**

An apparatus and method for a centrifugal pump (10) for pumping sensitive biologic fluid which includes (i) an integral impeller and rotor (21) which is entirely supported by an integral combination of permanent magnets and electromagnetic bearings (52, 54) and rotated motor (40), (ii) a pump housing and arcuate passages (32, 34, 36) for fluid flow and containment, (iii) a brushless driving motor (40) embedded and integral with the pump housing, (iv) a power supply, and (v) specific electronic sensing of impeller position, velocity or acceleration using a self-sensing method and physiological control algorithm for motor speed and pump performance based upon input from the electromagnetic bearing currents and motor back emf -- all fitly joined together to provide efficient, durable and low maintenance pump operation. A specially designed impeller and pump housing provide the mechanism for transport and delivery of fluid through the pump to a pump output port with reduced fluid turbulence.

These Notes are intended to give the basic instructions concerning the form of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty and the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

## INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

**What parts of the international application may be amended ?**

The claims only.

The description and the drawings may only be amended during international preliminary examination under Chapter II.

**When ?** Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

**Where not to file the amendments ?**

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

**How ?** Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

**What documents must/may accompany the amendments ?**

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confounded with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.